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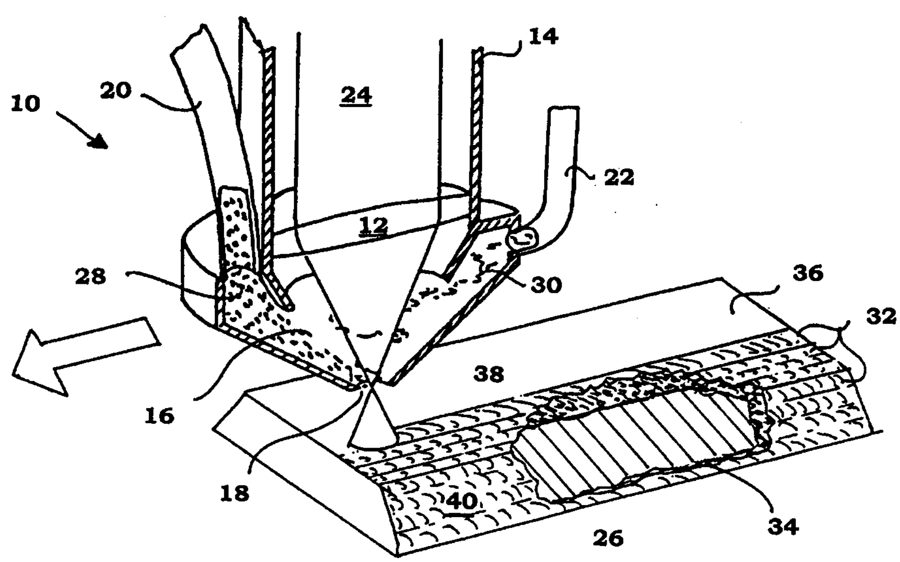
(54) Title: SURFACE HARDENING BY PARTICLE INJECTION INTO HIGH ENERGY BEAM MELTED SURFACE



(57) Abstract

The present invention relates to a method for treating functional surfaces, i.e. surfaces determining tolerance and position accuracy, on objects (26) of metal, hereafter named matrix material. The invention is characterised in that the functional surfaces are obtained by melting certain areas of the surface layer of the object with high energy and simultaneous supply of additive (28) comprising wear resistance increasing material.

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Surface hardening by particle injection into high energy beam melted surface.

TECHNICAL FIELD

The present invention relates to a method for treatment of functional surfaces, i e surfaces determining tolerance and position accuracy, on metal objects.

BACKGROUND OF THE INVENTION

Within machining industry, cutting as well as other industry, the demands on the accuracy regarding tolerance and position of surfaces on the machined articles increase. This in turn leads to an increase in the demands on accuracy on the machines and devices associated with these, such as reference surfaces on clamping devices and fixtures, surfaces on tool holders, partly in connection with the tool and partly in connection with the fixation in the machine, and the like. These surfaces, hereafter named functional surfaces, are surfaces which are determining for the tolerance and position accuracy. At the same time as the accuracy is an important factor, so is also the wear resistance of these surfaces in many cases an important factor. With regular change of for example fixtures and tools in a tool holder, the functional surfaces must not be worn so that the accuracy is lost.

Different attempts with more or less success have been made to harden functional surfaces in order to increase the wear resistance. For fixtures, hardmetal ledges have in certain cases been soldered, which is a time-consuming and relatively expensive method. Also nitriding of reference surfaces have been used. Thereby it is difficult and cumbersome to limit the nitriding to certain surfaces because masking has to be performed on the surfaces that are not to be nitrided. Nitriding also leads to a depletion of chrome in chrome containing steels because chrome nitrides are formed during

nitriding. The chrome nitrides lead to a hardening of the surface but at the same time lead to a reduction of the chrome content in the base material, which is a drawback in corrosive environments such as for example during electro spark machining where the work piece/fixtures are placed in liquid.

BRIEF DESCRIPTION OF THE INVENTION

The aim of the present invention is to perform treatment of function surfaces without the drawbacks of the state of the art. This is achieved according to one aspect of the invention with a method according to the preamble of this specification characterised in that the functional surfaces are obtained in that certain areas of the surface layer are melted with high energy with simultaneous supply of additives comprising wear resistance increasing material.

According to another aspect of the invention, it is characterised in that the functional surfaces subsequently are machined to desired form and dimension.

According to a further aspect of the invention, it is characterised in that the additive also comprises corrosion resistance increasing material.

According to yet another aspect of the invention, it is characterised in that the additive also comprises material capable of increasing the matrix material's ability to hold the wear resistance increasing material in the surface layer.

The advantages with the method of the invention are several. By melting only the surface layer with supply of the additive, a very good metallic bonding of the hardening material in the matrix material is obtained without the rest of the matrix material being heated. The

method enables controlled hardening of desired surfaces with desired depth of the layer on the objects without affecting the rest of the surfaces and without the need of protecting them.

With supply of corrosion resistance increasing material, depletion of the matrix material in connection with corrosion preventing material is prevented.

With supply of material capable of increasing the ability of the matrix material of holding the hardening material, relatively soft matrix materials may be used, which materials, when adding only hardening material, tend to not be able to hold the hardening material, with a consequence that this is torn off, whereby the wear resistance is reduced. Thereby, material with a relatively high modulus of elasticity, which often are relatively soft, may obtain a harder surface layer with improved wear properties, whereby a combination of properties is obtained.

These and other aspects of the present invention and advantages with it will become apparent from the detailed description of a conceivable embodiment and by the appended patent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following description of a conceivable embodiment reference will be made to the attached drawings, of which

Fig. 1 shows a method for surface treatment of a metal object comprised in the invention,

Fig. 2 shows one way of producing functional surfaces according to the invention,

Fig. 3 shows another way of producing functional surfaces, and

Fig. 4 shows a further alternative.

DETAILED DESCRIPTION OF THE INVENTION

The method according to the invention starts from melting a surface layer on a metal article to be treated with highly concentrated energy. In Fig. 1 a laser head 10 is shown, connected to a high power laser (not shown). The laser head comprises a prism 12 arranged in a cylindrical enclosure 14 open downwards. Around the opening a chamber 16 is arranged also this with an opening 18 downwards. A first connection 20 is arranged to the chamber for supply of material, hereafter named additive. A second connection 22 is also arranged to the chamber for supply of protective gas.

In use, a laser beam 24 is transmitted through the enclosure and is refracted in the prism whereby a concentrated area of the material of an article 26, hereafter named matrix material, is heated over the melting point. At the same time a suitable additive 28 is supplied to the chamber, which falls down through the opening 18 and is supplied to the smelt, and also protective gas 30. The laser head is moved continuously over the surface to be treated, often in the form of bands 32. The molten area solidifies, whereby a very good metallic and homogenous bonding between the additive and the matrix material is obtained in a surface layer 34, where the additive is arranged as evenly distributed particles in the surface layer. Because a very local and quick heating is provided, other areas of the matrix material are not affected, only the heated zone.

In Fig. 1 and 2 is shown an example of how the method according to the invention may be employed for producing reference surfaces, i e surfaces acting as fixating points for positioning of work pieces in relation to tools, measuring equipment and the like, which surfaces must have a certain tolerance that may not be altered after repeated use of machines, fixtures and the like. The reference surfaces are often formed as two- or three-dimensional bodies in order to function

as reference in several axes. A metal article 26 is provided with ledges or protrusions produced before-hand, during for example casting of the article or after cutting machining. The surfaces on these ledges 38, 40, either fully or in part, are surface treated according to the above described method whereby a surface layer 32 is melted and provided with a wear resistance increasing additive. After the treatment the surfaces are machined with a suitable machining method to the right tolerances and position, see the broken line of Fig. 2. In Fig. 2 a clamping part 42 is also shown, intended to fit together with the ledge 36. The clamping part is also treated with the above method on suitable surfaces 44. The clamping part may also comprise details 46 with untreated surfaces with a certain flexibility in the construction in order to provide accurate positioning between the fixture and the clamping part.

Fig. 3 shows a variant of the production of ledges and the like guides with reference surfaces. In this case, the article is not pre-formed but instead suitable areas are first surface treated with the above method. During the surface treatment, the thickness of the surface layer is varied at different areas with respect to the subsequent manufacture of reference surfaces by varying the power density from the laser and the feed speed. In Fig. 3 a first area 50 is shown where the thickness of the surface layer is relatively small and then pass into a second area 52 with a thicker surface layer, i e larger depth of penetration. When the article has been surface treated, it is machined to desired shape and tolerances, the broken line 54 of Fig. 3. For the thinner surface layers a lesser machining is performed, while a larger machining is performed for the thicker surface layers, in order to obtain reference surfaces in different planes, all containing wear resistance increasing additives. In the figure machining with a grinding wheel 60 is shown schematically for production of reference surfaces.

Figure 4 shows an example of the manufacture of functional surfaces on a tool holder 70. In this case one starts off with a pre-formed tool holder intended for a tool with a certain shape, for example an insert. Then, suitable and chosen surfaces are surface treated on the pre-formed holder according to the aboe method such as the seat of the insert 72 and the clamping surfaces 74 of the holder. These surfaces are then machined with a suitable method, for example such as electro spark machining, in order to obtain the right dimensions and tolerances.

The additives supplied may be of different kind depending on desire and functional requirements. A general desire is that the wear resistance is as high as possible for the reference surfaces so that the tolerances are not lost during repeated use. In that context, the additive can comprise metallic oxides, carbides, borides, nitrides or ceramics, which provide an increased hardness and wear resistance.

Specific demands are put on certain applications of use. For example electro spark machining is performed with the work piece and fixtures immersed in liquid. In order to obtain an adequate protection against corrosion, the matrix material can contain a chrome content of at least 12%. A surface treatment according to above method may lead to that a part of the chrome is transferred to hardening chrome carbides, which in turn leads to a depletion of chrome in this layer, with reduced corrosion resistance as a consequence. Because of this, the additive may, in addition to hardening materials, also contain chrome in order to maintain the chrome content in the surface layer.

Also in other areas of use where the requirements of corrosion resistance are not as high it may be an advantage to increase the corrosion resistance for at least the reference surfaces, whereby chrome is supplied to the surface layer via the additive, in addition to

the wear resistance increasing material, in order to increase the chrome content in the surface layer.

For certain areas of use, one wishes to have a relative soft matrix material with certain exposed areas hardened. Generally this leads to problems because the matrix material cannot bind the additive, for example hardening material, to a sufficient extent, which follows that the hardening material is torn off. In this context the matrix material's ability to hold the hardening material can be increased. An example are austenitic steel alloys. By, together with the hardening material, also include ferrite forming material, the surface layer obtains a transfer from austenitic to austenite-ferritic, which increases the matrix material's ability to hold the hardening material. By this a combination of a softer matrix material with relatively high modulus of elasticity and a harder surface layer with good wear properties can be obtained, which is an advantage in certain applications.

The ferrite-forming materials may be chrome, molybdenum, niobium, titanium, tantalum, tungsten, vanadium, zirconium and silicon.

It is to be understood that the invention is not limited to the above described and in the drawings shown embodiment but may be altered within the scope of protection of the appended claims. Thus, the name functional surfaces also relate to the slide of a machine tool and other surfaces between machine parts that either slide against each other or in another way are fixated/arranged against each other, because these surfaces also are determining for the precision, tolerances and positions of the machine.

Even if the method for surface treatment has been described by using laser, it shall be understood that other high-power sources may be

employed in order to provide controlled melting of the surface layer of the article.

PATENT CLAIMS

1. Method for treatment of functional surfaces on metal objects (26), hereafter named matrix material, that the functional surfaces are obtained by melting certain areas of the surface layer of the object with high energy and simultaneous supply of additives (28) comprising wear resistance increasing material, c h a r a c t e r i s e d in that said functional surfaces are surfaces intended to determine tolerance and position accuracy of details/components arranged in contact with these surfaces.

2. Method according to claim 1, c h a r a c t e r i s e d in that the functional surfaces subsequently are machined to desired form and dimension.

3. Method according to claim 2, c h a r a c t e r i s e d in that the thickness of the surface layer is varied dependent on the degree of the subsequent machining.

4. Method according to claim 1, c h a r a c t e r i s e d in that the surface layer is melted with laser beams.

5. Method according to claim 1, c h a r a c t e r i s e d in that the additive also comprises corrosion resistance increasing material.

6. Method according to claim 5, c h a r a c t e r i s e d in that the matrix material comprises a chrome content of at least 12% and that the additive comprises chrome.

7. Method according to claim 1, c h a r a c t e r i s e d in that the additive also comprises material able of increasing the matrix material's ability to hold the hardening material.

8. Method according to claim 7, c h a r a c t e r i s e d in that the matrix material is an austenitic steel alloy and that the additive comprises ferrite-forming alloying elements.

9. Method according to claim 8, c h a r a c t e r i s e d in that the ferrite-forming alloying elements comprise chrome, molybdenum, niobium, titanium, tungsten, tantalum, vanadium, zirconium and silicon.

10. Method according to claim 2, c h a r a c t e r i s e d in that the machining is performed by grinding.

11. Method according to claim 2, c h a r a c t e r i s e d in that the machining is performed by electro spark machining.

12. Method according to any of the preceding claims, c h a r a c t e r i s e d in that the wear resistance increasing material comprises metal carbides, -oxides, borides, nitrides or ceramics.

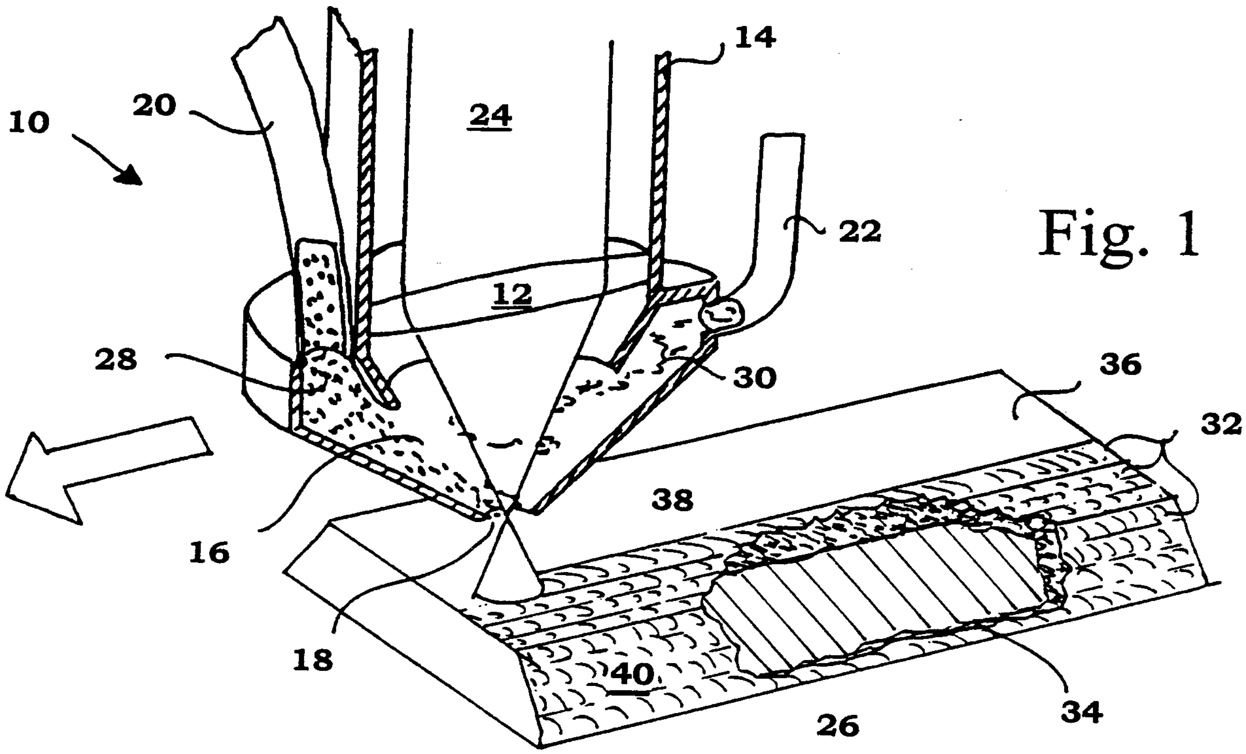


Fig. 1

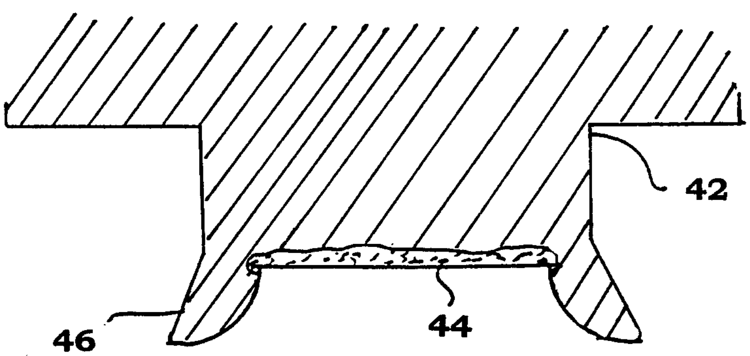
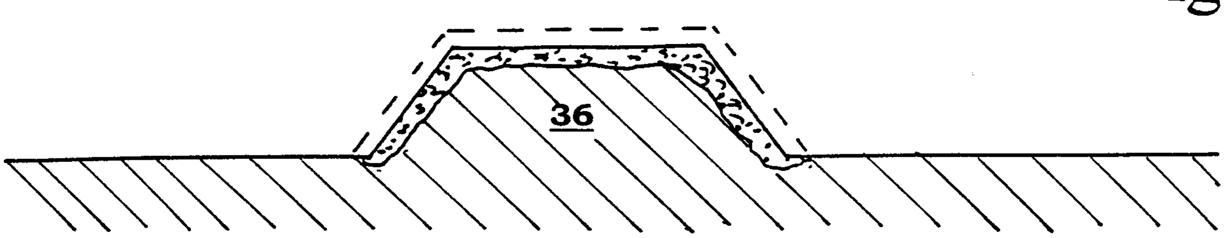


Fig. 2



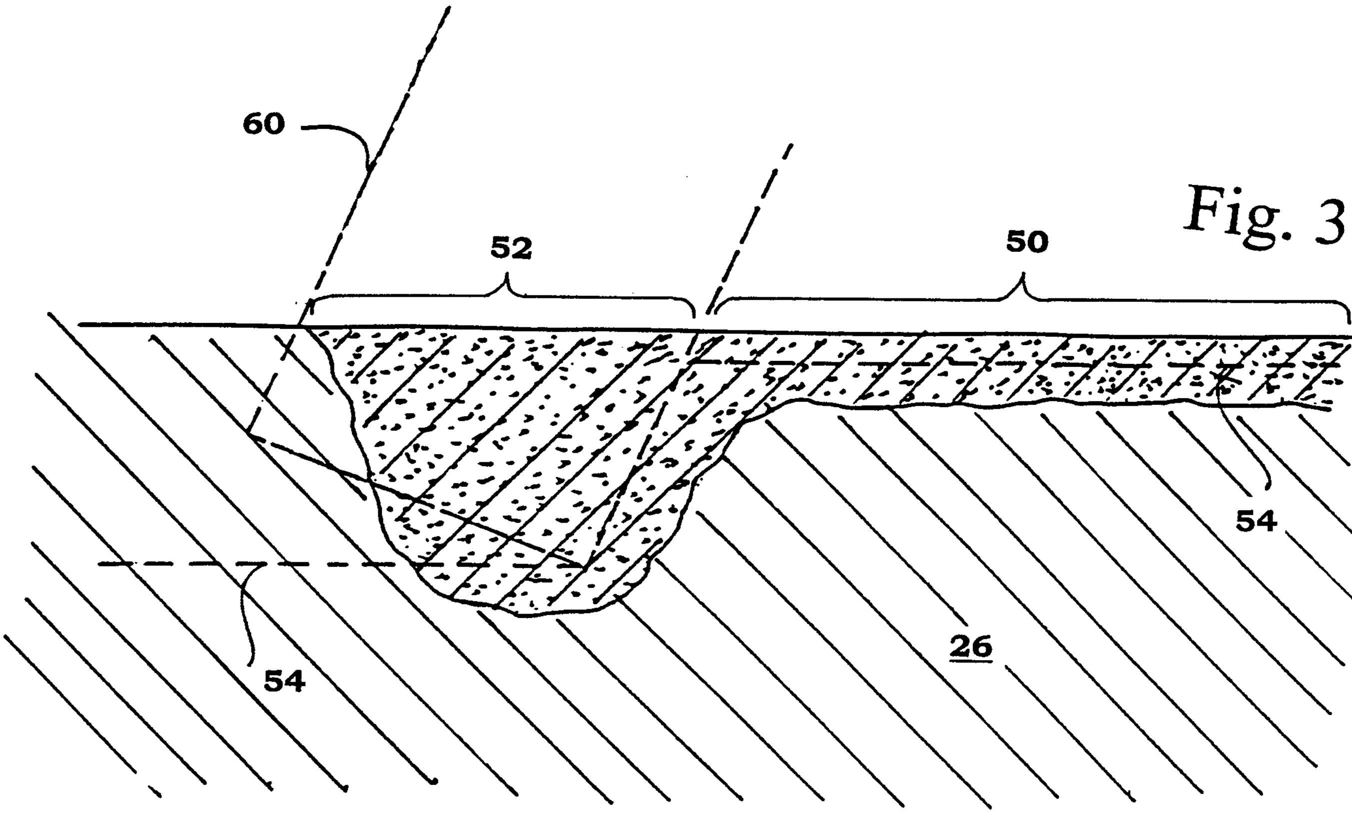


Fig. 3

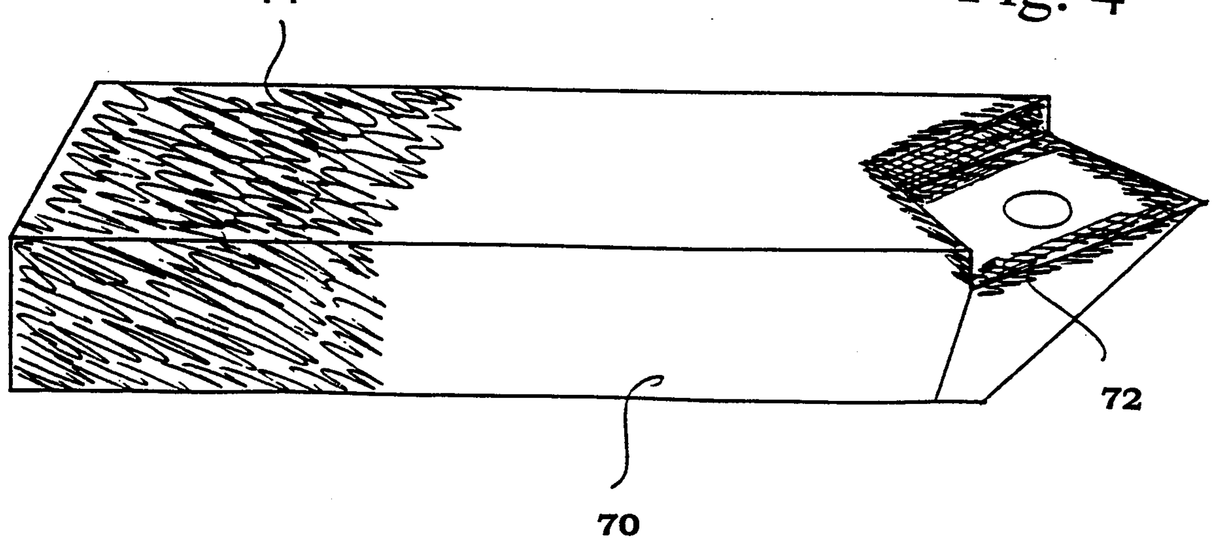


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00755

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B23K 26/00, C23C 24/10, C21D 1/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B23K, C23C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 4130207 A1 (INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE), 25 March 1993 (25.03.93), column 1, line 11 - line 21, abstract --	1-11
X	US 4299860 A (ROBERT J. SCHAEFER ET AL), 10 November 1981 (10.11.81), column 1, line 3 - column 2, line 44 --	1,4,12
A	JP 62227095 A (SUMITOMO METAL IND LTD) 1987-10-06 (abstract) World Patents Index (online). London U.K.: Derwent Publications, Ltd. (retrieved on 1999-08-27). Retrieved from: EPO WPI Database. DW 8745. Accession No. 87-318299 -- --------	6-9

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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DE 4130207 A1	25/03/93	NONE	
US 4299860 A	10/11/81	CA 1155158 A	11/10/83